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Research article

Analysis of Understanding and Readiness of Elementary School Teachers on the Implementation of the STEAM (Science, Technology, Engineering, Arts, Mathematics) Approach

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Abstract.
The application of integrated thematic learning and scientific approaches to the 2013 curriculum in Indonesian elementary schools can be done using the STEAM (Science, Technology, Engineering, Arts, Mathematics) approach because learning activities in the 2013 curriculum have been developed based on themes, sub-themes and lessons that have been adapted to life and student environment. Of the total respondents in the study, 37.6% understood the STEAM approach well, 40.8% expressed doubt, and 21.6% did not know about it. The results of the interviews with several teachers indicated that STEAM is art-based learning and that the elementary school teachers' understanding of STEAM is far from its real nature. Based on this, the researchers have used a descriptive–analytical design to analyze the understanding and readiness of elementary school teachers toward the implementation of the STEAM approach in eight districts of Central Java Province. The results showed that teachers did not fully understand the concept or practice of learning using the STEAM approach despite having delivered projects based on STEAM. The authors, therefore, recommend that teachers must pay attention to the readiness and needs of students, and design and prepare STEAM learning tools based on the descriptions of basic competencies and indicators on the themes, sub-themes, and lessons that will be taught to the students.

Keywords: teacher understanding, teacher readiness, implementation of STEAM (Science, Technology, Engineering, Arts, Mathematics)

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1. Introduction

The application of integrated thematic learning and scientific approaches to the 2013 curriculum in elementary schools can be integrated with the STEAM (Science, Technology, Engineering, Arts, Mathematics) approach, because learning activities in the 2013 curriculum have been developed based on themes, sub-themes and lesson content that are adapted to life and student environment. Teachers can invite students to relate

the material being studied with real experiences or examples in students' daily lives. Thus, students will be able to identify and analyze the acquired knowledge, express ideas and determine attitudes to create simple works as a tangible manifestation of the achievement of cognitive, affective and psychomotor learning outcomes on an ongoing basis. STEAM learning has an influence on students' creativity and can be a learning solution for students in dealing with technological developments that are combined with science. In addition, there is also the effect of STEAM learning through Problem Based Learning on student learning outcomes [1,2].

STEAM education as a problem-solving procedure that results in increased STEAM literacy and concept development through sharing opinions. Most of the students indicated that they would frequently use the knowledge they learned in the STEAM program in science class to enable them to have a better understanding of the problem-solving process. Therefore, STEAM programs in science classes tend to contribute to STEAM literacy through the integration of science, technology, and the arts to develop problem solving skills by introducing new ideas[3]. The application of the STEAM learning model can strengthen students' literacy and positive response to learning[4].

Based on preliminary study data through interviews and questionnaires to elementary school teachers in 8 districts in Central Java Province, it shows that 100% of teachers have implemented thematic learning, although some are still xperiencing difficulties in implementing it. n the implementation of thematic learning using problem-based learning by engaging students in the discovery process[5].

The teacher has also applied a scientific approach but only refers to the teacher's book. Teachers are also not familiar with the STEAM approach, the teachers say that there is a lot of information about STEAM but they do not understand it in depth and have never implemented STEAM in learning. Respondents who strongly agree have heard of the STEAM approach as much as 37.6%, agree as much as 40.8%, and 21.6% of respondents expressed doubt and did not know STEAM. The results of interviews with several teachers stated that STEAM is an art-based learning. The teacher's understanding of STEAM is certainly not in accordance with the nature of STEAM.

According to[6] with the holding of STEAM learning training teachers can gain a good understanding of the concept of STEAM-based learning, see the suitability of thematic learning in elementary school because both are not limited to rigid subjects, but can be integrated into various subjects that are packaged into one theme so that it can be seen in aspects of science, technology, engineering, art, and mathematics. The STEAM approach is experiencing an increasing trend in the implementation of learning

in schools, but research is limited to the practice of STEAM learning. Teachers need to design a STEAM curriculum.

The results of the interviews also show that during the implementation of learning so far the teacher has given several projects to students either individually or in groups, but these projects are only seen as assignments. The teacher has used learning media to explain the material not for project work. The teacher said that he had implemented thematic learning by integrating 2 to 3 lesson content, but in the delivery of the lesson content it seemed still separate, for example in the delivery of science material the teacher tended to choose to use a scientific approach, while in the delivery of mathematics the teacher used a problem-solving approach. [7] states that the application of STEAM ideas and concepts in learning mathematics must be followed by the ideas of the disciplines contained in STEAM, namely science, technology, engineering, art, and mathematics. Some math topics that can be applied with STEAM-based learning include building space, probability, social arithmetic, trigonometry, and others. The implementation of STEAM in learning mathematics can develop abilities and skills that are useful for students to face the challenges of the globalization era in the future.

Several studies have shown advantages regarding the application of the STEAM approach in learning. According to [7] through innovative STEAM learning in elementary schools, students have direct experience so that they build a more meaningful understanding of learning materials.[8] Stated that STEM Project Based Learning can improve scientific work skills and scientific literacy skills. The application of STEAM is needed both in the disciplines of science, technology, engineering, art, and mathematics as well as in everyday life. The results of the research conducted showed that the experimental group students who applied STEAM showed the physical characteristics of scientists from a broader perspective[9].

For the readiness of learning resources in implementing the STEAM approach, [10] stated that the material contained in teacher and student books has a lot of potential for STEAM (Science, Technology, Engineering, Art, Mathematics), it's just a matter of how a teacher can apply the STEAM approach (Science, Technology, Engineering, Art, Mathematics) in their learning activities. [11] state that teachers in schools have tried to find information about STEAM-based learning so that they can keep up with the times and children's creativity can also be explored to the maximum, one of which is by applying STEAM-based learning by using learning media in the form of loose parts. Based on the findings that have been described on the background of the problem, the researchers are interested to analysis focused on how to analyze the understanding

and readiness of elementary school teachers towards the implementation of the STEAM approach (Science, Technology, Engineering, Arts, Mathematics).

2. Method

This research applied a descriptive analytical method that is used to analyze the understanding and readiness of elementary school teachers to the implementation of the STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach in 8 districts, Central Java Province. This research is an analytical descriptive study, so that in obtaining as much data as possible, it is carried out through various techniques that are arranged systematically to find perfect data collection results. The author conducts research with descriptive studies because it is in accordance with the nature of the problem and the research objectives to be obtained. Analytical descriptive method is a method that aims to describe or provide an overview of an object of research that is studied

through samples or data that have been collected and make generally accepted conclusions[12]. This research was conducted using observation, interview, questionnaire, and documentation techniques to obtain relevant data according to the real situation in the field.

The subjects in this research were elementary school teachers in 8 districts, Central Java Province. The sample of this research is 125 teachers from public and private elementary schools. Research data collection techniques were taken by using the methods of observation, interviews, questionnaires, and documentation. the validity of the data using the constancy of observation and triangulation. The data analysis technique used in this research is data collection, reduction, presentation, and conclusion drawing.

3. Result and Discusion

Based on the results of questionnaires and interviews with elementary school teachers on the understanding and readiness of elementary school teachers towards the implementation of the STEAM approach, the following results were obtained:

Aspects of teachers' understanding of the STEAM approach are described in the statement that the STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach is very foreign to teachers, the STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach is widely available in the mass media, but I do not know what STEAM is, the STEAM (Science, Technology, Engineering, Arts, and Mathematics)

Table 1: Elementary School Teachers' Understanding of the STEAM Approach.

Aspects of understanding STEAM	Strongly Disagree	Disagree	Doubtful	Agree	Strongly Agree
Aspects 1	22	27.2	25,6	20.8	4.8
Aspects 2	14.4	33.6	32	16.8	3.2
Aspects 3	0.8	7.2	35.2	40.8	16
Aspects 4	0.8	4.8	32.8	37.6	24
Aspects 5	1.6	7.2	21.6	49.6	20

approach is very easy to apply as a new approach, the STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach makes learning activities easier, and teachers do not feel difficult to give student assignments in the form of projects.

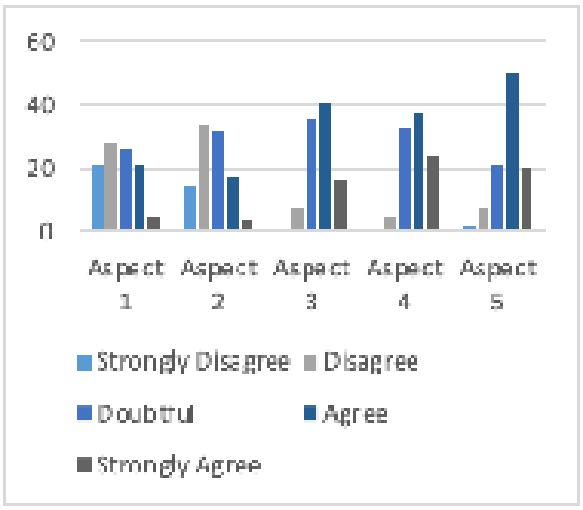


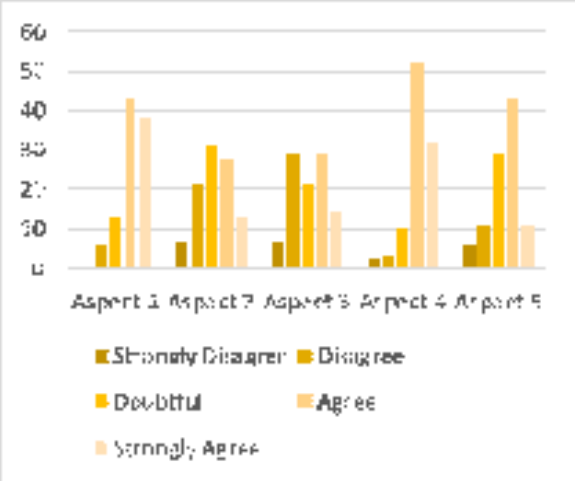
Figure 1: Diagram of Elementary Teacher's Understanding of the STEAM Approach.

Table 1 and Figure 1 show that there are 5 aspects of statements related to aspects of teacher understanding of the STEAM approach. All respondents stated that in the statement the STEAM approach (Science, Technology, Engineering, Arts, and Mathematics) was very foreign to teachers. Some teachers stated that the STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach was widely available in the mass media, but the teachers did not know the STEAM approach. As many as 40.8% of respondents agreed that the STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach is very easy to apply as a new approach, 16% strongly agree and others express doubt and disagree. This is because teachers have never received direct information or training related to the STEAM approach. A total of 37.6% of respondents agreed that the STEAM (Science, Technology, Engineering, Arts, and Mathematics) approach facilitates learning activities, 24% strongly agree, and other respondents are still hesitant and disagree. As many as 20% of respondents strongly agree if they do

not find it difficult to give student assignments in the form of projects, 49.6% agree, but there are still respondents who doubt and disagree with the statement.

TABLE 2: Readiness of Elementary School Teachers for the Implementation of the STEAM Approach.

Elementary teacher readiness STEAM aspects	Strongly Disagree	Disagree	Doubtful	Agree	Strongly Agree
Aspects 1	0	5.6	12.8	43.2	38.4
Aspects 2	6.4	21.6	31.2	28.0	12.8
Aspects 3	6.4	28.8	21.6	28.8	14.4
Aspects 4	2.4	3.2	10.4	52	32
Aspects 5	5.6	11.2	28.8	43.2	11.2



Aspects of the readiness of elementary school teachers to the implementation of the STEAM approach are described in a statement to facilitate the delivery of material teachers always use learning media available in schools, in learning activities teachers use learning media but not as much as possible, learning media in schools are very complete making it easier for teachers to use it, so that teachers do not need to bring their own from home, teachers have given assignments in the form of projects to students, and in giving project assignments sometimes teachers have difficulty in choosing the form of projects that the teacher must give to students and according to the teacher's book. So that teachers do not need to bring their own from home, teachers have given assignments in the form of projects to students, and in giving project assignments sometimes teachers have difficulty in choosing the form of projects that the teacher must give to students and according to the teacher's book.

Based on Table 2 and Figure ?? it can be seen that 38.4% of respondents strongly agree and 43.2% agree that to facilitate the delivery of material teachers always use learning media available in schools. This shows that in schools there are media that can support the implementation of the STEAM approach, but 12.8% of respondents stated

strongly agree and 28% agree, if they have not used the media as much as possible. A total of 14.4% of respondents stated that they strongly agree that the learning media in schools are very complete, making it easier for teachers to use them, so that teachers do not need to bring their own from home, 28.8% agree and other respondents are hesitant and disagree. This is because the completeness and availability of learning media available in each school is different, and some projects still require materials that need to be prepared independently by students or teachers. As many as 32% of respondents strongly agree and 52% agree that they have given assignments in the form of projects to students, only 16% stated that they have never given projects. In giving projects to students, 11.2% of respondents strongly agree and 43.2% agree that sometimes they have difficulty in choosing the right form of project according to the teacher's book that is easy for students to master. This shows that teachers already have experience in implementing projects so that they can be used as references in implementing the STEAM approach, but assistance and training related to further STEAM implementation are needed so that they do not only refer to teacher books and can be adapted to student needs.

Table 3: Potential Student Projects in the STEAM Approach.

NO	Project Name	STEAM potential analysis	
		Yes	No
1	Clouds in a glass	√	-
2	Playing a musical instrument	√	-
3	Windmills and waterwheels	√	-
4	Playing traditional musical instruments	√	-
5	Properties of gas objects using balloons	√	-
6	Artificial magnets and electricity	√	-
7	Heat conductor	√	-
8	Singing and playing musical instruments	√	-
9	Filtration of dirty water to be clean	√	-
10	Electrical circuits using used batteries and cables	√	-
11	Transplanting plants	√	-
12	Experiments prove the properties of sound	√	-
13	Making 3D works of clay	√	-
14	Experimental change of state of matter	√	-
15	Make a simple respiratory organ model	√	-

Based on Table 3, it shows that all projects that have been given to students have the potential to be integrated in the STEAM approach, but in practice they are still focused

on only one STEAM element in each lesson content. In the science element, the teacher tends to give science material, the teacher gives a cloud in a glass project to explain and prove the process of the occurrence of clouds in the sky, the windmill project is used to explain changes in force and energy, an artificial magnet making project to prove several ways to make magnets, a water filtration project to demonstrate tools, materials, and how water purification works, as well as series and parallel electrical circuit projects. Meanwhile, the Art element was given by the teacher during the cultural arts and crafts material with singing projects and playing musical instruments. If, observed and analyzed in depth, the project can be integrated in a continuous STEAM approach, as well as thematic learning that is integrated with each other between lesson content.

In implementing the STEAM approach for a windmill making project, for example the element of science in science content, students can define force and energy. On the technology element in the social studies content, students compare technological developments from time to time. In the engineering element in science content, students can analyze the technique of making windmills. In the art element in the cultural arts and crafts content, students can create interesting simple works. In the mathematics element in Mathematics, students can determine the size of the windmill, the size and the number of angles that must be folded and cut in making a windmill.

Next, implementation of STEAM approach for electrical circuit making projects, such as elements of science in science content, students can define related electrical circuits, both series and parallel circuits. In the technology element in the social studies content, students can determine the type of electrical circuit used in the household to be more efficient and efficient. In the engineering element in the citizenship education content, students can determine the behavior that family members must do to save electricity. In the art element in the cultural arts and crafts content, students can make simple works in the form of simple electrical circuits. In the mathematics element in Mathematics, students can calculate and determine the amount of substitute resistance, current and voltage in an electrical circuit. This is in line with the results of the implementation of STEAM through the introduction of electric circuits in elementary schools showing that the experimental group students who applied STEAM showed the physical characteristics of scientists from a broader perspective[9].

The implementation of STEAM approach for water filtration projects, for example the element of science in science content, students can communicate the results of a simple water purification experiment project, which can also be linked to mixed materials. In the technology element in social studies content, students can relate the material to water and environmental pollution, as well as their impact on human life. In the engineering

element in the content of Civics, students can determine the behavior that students must do in preventing water pollution both in the home or school environment. In the art element in the cultural arts and crafts content, students can make simple works in the form of simple water purification tools. In the mathematics element in Mathematics, students can calculate and determine the size of the water purification tube, as well as the ratio of the materials used to purify water.

Teachers can identify and analyze other projects that can be integrated into STEAM by adjusting student needs and conformity with basic competencies and lesson content indicators in specific themes. By integrating thematic learning with the STEAM approach, it is expected to train students in developing their creativity. In addition, the integration of the STEAM approach in project-based learning is also an interesting, exciting, and fun learning and can develop the soft skills of students [13].

4. Conclusion

Based on the results and discussion, it can be concluded that teachers do not fully understand the concept or practice of implementing learning using the STEAM approach even though in the implementation of learning they have given projects as a form of implementing the STEAM approach. All projects that have been given by teachers to students have STEAM potential, thus supporting the readiness of teachers to implement STEAM in learning. In implementing the STEAM approach, teachers need to pay attention to the readiness and needs of students, design and prepare STEAM learning tools according to the descriptions of basic competencies and indicators on the themes, sub-themes and learning that will be taught to students.

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